

ADVENTURES INSIDE THE

ATOM



ADVENTURE SERIES

Produced by
GENERAL ELECTRIC COMPANY
by GENERAL CONTROL, Inc.

ALL ENERGY HAS ALWAYS COME FROM "OUT-OF-THIS-WORLD." THE FAR-OFF SUN HAS GIVEN US INDIRECTLY THE STORED ENERGY OF COAL AND OIL... THE LIVING ENERGY OF PLANTS AND ANIMALS (AND OF HUMANS, TOO)...

TODAY, SCIENTISTS HAVE FOUND THE SOURCE OF THE SUN'S STRANGE AND WONDERFUL ENERGY LOCKED IN THE HEART OF THE ATOM... ARE RELEASING THAT ATOMIC ENERGY TO SERVE US ALL IN THE FUTURE AS A SOURCE OF ALMOST UNLIMITED POWER.

HERE IS THE THRILLING STORY OF MAN'S GREATEST ADVENTURE INTO THE UNKNOWN... AND THE DISCOVERY OF NATURE'S GREATEST SECRET!

THE STORY OF NUCLEAR ENERGY



"THE MODERN MIRACLE OF ATOMIC POWER IS THE CLIMAX OF A NEVER-ENDING SEARCH FOR KNOWLEDGE. IT ALL BEGAN MORE THAN 2,000 YEARS AGO IN ANCIENT GREECE..."



"MIND NOT THOSE DOUBTERS, MASTER. TELL ME MORE."

"ALL THINGS AROUND US—TREES AND GRASSES AND EVEN OUR OWN BODIES—ARE MADE OF 'BUILDING BLOCKS' SMALLER THAN ANYTHING YOU CAN IMAGINE. I CALL THEM 'ATOMS.'"



"AND A FEW YEARS LATER, ARISTOTLE ADDED AN IDEA OF HIS OWN."

"IT MUST BE THAT ALL THE THOUSANDS OF THINGS ON EARTH ARE COMBINATIONS OF CERTAIN BASIC 'ELEMENTS.'"



"FOR CENTURIES AFTER THAT, MEN CALLED 'ALCHEMISTS' STRUGGLED TO FIND THE COMBINATION OF ELEMENTS WHICH WOULD MAKE PRECIOUS GOLD..."



"TAKE THAT FOR WAITING THE LONG TIME."



"IN 1808, A QUAKER SCHOOL TEACHER, JOHN DALTON, SUGGESTED..."



"WITH ALL OUR KNOWLEDGE OF CHEMISTRY, WE CANNOT CHANGE THE ATOMS OF OTHER ELEMENTS INTO GOLD BECAUSE..."

"GOLD IS ITSELF A BASIC ELEMENT. THE ATOMS OF EACH ELEMENT ARE DIFFERENT FROM THE ATOMS OF ALL OTHER ELEMENTS."



"BETWEEN 1860 AND 1900, SCIENTISTS TRIED TO EXPLORE INSIDE THE ATOM..."



"PERHAPS THE ATOM, WHICH WE HAVE THOUGHT THE SMALLEST POSSIBLE PARTICLE, IS ITSELF MADE UP OF PARTS."

"...AND THESE PARTS ARE HELD TOGETHER BY ELECTRICAL ATTRACTION."

"BUT THERE MUST BE SPACES BETWEEN THESE PARTS INSIDE THE ATOM."

"AND IN 1913, A DANISH SCIENTIST, NAMED NIELS BOHR, COMBINED THESE THEORIES INTO..."



"WELL, DR. BOHR: IT'S LIKE A 'SOLAR SYSTEM' WITHIN EACH TINY ATOM. ELECTRON 'PLANETS' WHIRLING AROUND A NUCLEUS 'SUN'..."

"GOSH, SO, YOU GURE MAKE ALL THAT HISTORY SEEM REAL!"



"THESE PICTURES AT THIS EXHIBIT HELPED. NOW YOU KNOW WE'VE BEEN WORKING ON THE ATOM FOR A LONG TIME."



"HEY, BOY, HOW DO YOU KNOW THIS ATOM IS NITROGEN—IT DOESN'T SAY?"

"YOU CAN ALWAYS TELL THE KIND OF ATOM BY THE NUMBER OF PLUS ELECTRICAL CHARGES—OR, 'PROTONS' IN THE NUCLEUS. HERE, COUNT THEM."

"4...5...6...7... PROTONS. HM, NUMBER SEVEN, YOU'RE RIGHT—NITROGEN."

"YOU SEE, EACH OF THE 92 ELEMENTS IN NATURE—FROM THE SMALLEST TO THE LARGEST—IS GIVEN AN ATOMIC NUMBER EQUAL TO ITS NUMBER OF PROTONS."

"EIGHT PLUSSES—THIS MUST BE OXYGEN...BUT ED, WHAT ARE THE BLACK BALLS MIXED UP IN THERE?"

"THOSE ARE 'NEUTRONS.' THEY ARE EXTRA WEIGHTS WITHOUT ANY ELECTRICAL CHARGE."

"RECALL: AN 'ATOM'S NUMBER' IS THE NUMBER OF PROTONS, AND AN 'ATOM'S WEIGHT' IS THE NUMBER OF PROTONS AND NEUTRONS."

TYPICAL ATOMS

NO.	ELEMENT	PRO- TONS	NEU- TRONS	WT.
8	OXYGEN	8	8	16
26	IRON	26	30	56
79	GOLD	79	118	197
92	URANIUM	92	146	238

"YOU MEAN THAT, IF I TOOK OUT SOME OF THOSE PLUSSES, IT WOULD CHANGE THE ATOM TO ANOTHER KIND—THAT'S EASY?"

"EASY, IS IT? REMEMBER, ALCHEMISTS WORKED FOR CENTURIES BUT COULDN'T TAKE THREE PLUSSES OUT OF 82 LEAD AND GET 79 GOLD."

"BUT, STRANGELY ENOUGH, SOME ELEMENTS CHANGE BY THEMSELVES. ANTOINE HENRI BECQUEREL FOUND ONE IN 1896..."

MADAME CURIE, I CAN'T UNDERSTAND IT... THE URANIUM GIVES OFF SOME STRANGE KIND OF 'RAY'!

PLEASE, PROFESSOR, LET ME EXPERIMENT WITH IT.



BETWEEN THE TWO OF THEM, THEY DISCOVERED THAT CERTAIN ELEMENTS ARE 'RADIO-ACTIVE'... THAT IS THEY SHOOT OFF SOME OF THEIR PROTONS. HEHE, I'LL SHOW YOU.



I GET IT-IT'S SHOOTING OFF PLUS CHARGES!

EXACTLY! LET'S SUPPOSE THIS SPARKLER IS RADIOACTIVE, OR NOT, URANIUM. YOU SEE 92 URANIUM LOSES PLUS CHARGES UNTIL IT BECOMES 88 RADIUM AND...



OH-OH... THE SPARKLER STOPPED BURNING.

YES... AND, AFTER CENTURIES, RADIOACTIVE ELEMENTS 'BURN OUT' TOO. EACH 88 RADIUM NUCLEUS LOSES PLUS CHARGES UNTIL IT FINALLY HAS BECOME 82 LEAD, A STABLE, OR 'GOLD,' ELEMENT.



THIS WHOLE PROCESS IS CALLED 'NATURAL TRANSMUTATION'. WHY IT HAPPENS AND WHY IT STOPS, NO ONE KNOWS... BUT IT'S AN IMPORTANT PART OF OUR STORY, YOU SEE...



"AN ENGLISH SCIENTIST, SIR ERNEST RUTHERFORD, FOUND AN IMPORTANT USE FOR RADIOACTIVE ELEMENTS IN 1919..."



YOU MEAN SIR ERNEST, THAT YOU CAN USE THE PARTICLES COMING FROM THE RADIUM?

YES... THEY ARE MY 'BULLETS' WHICH I USE TO BOMBARD OTHER ATOMS. YOU NEVER CAN TELL WHAT WILL HAPPEN NEXT.





MEN HAVE ALWAYS USED ENERGY THAT CAME INDIRECTLY FROM THE SUN... BUT IN 1905 ALBERT EINSTEIN SAID, 'IN EVERY SPECK OF DUST HERE ON EARTH, A POSSIBLE SOURCE OF THAT SAME ENERGY...



'IF MATTER COULD BE DESTROYED ENERGY WOULD BE CREATED IN ITS PLACE'... WHAT NONSENSE! ... ALBERT WEITING.

WHY NONSENSE? ISN'T THAT WHAT HAPPENS WHEN I BURN THIS MATCH?

OF COURSE NOT! THAT'S ONLY A CHEMICAL REACTION. ACCORDING TO HIS FORMULA OF EINSTEIN'S... ENERGY EQUALS MASS TIMES THE SPEED OF LIGHT SQUARED! ...

DESTROYING COMPLETELY THE ATOMS OF THIS MATCH- STICK WOULD MELT ALL THE SNOW IN SWITZERLAND!



BUT, LUCKILY, SOME SCIENTISTS DID NOT LAUGH AND FOR 23 YEARS, THEY TRIED TO DESTROY MATTER AND RELEASE ENERGY. IN 1938, WILHELM OTTO HAHN AND FRIEDRICH STRASSMANN WERE TRYING TO PLOSTER PROTONS ON THE NUCLEUS OF ^{92}U URANIUM...



WELL, DOCTOR, WE FAILED AGAIN. AND HOW DID THIS 56 BARIUM GET IN WITH THE URANIUM?

STRANGE! HERE STRASSMANN, VERY STRANGE... I WISH DR. MEYNER WERE STILL HERE WORKING WITH US.

'AND, IN DENMARK, WHEN DR. MEYNER HEARD OF THE EXPERIMENTS...

NO WONDER DR. MEYNER IS SO EXCITED! SHE THINKS, PERHAPS, THE URANIUM ACTUALLY 'FISSIONED', OR SPLIT IN TWO!



BUT THE BARIUM AND KRYPTON LEFT BY THE SPLIT WEIGH LESS THAN THE ORIGINAL URANIUM. COULD THAT BE?...?

"WORKING ON LISE MEITNER'S CLUE, NIELS BOHR ORGANIZED FURTHER EXPERIMENTS BEFORE LEAVING FOR AMERICA AND, SOON AFTER, AT GEORGE WASHINGTON UNIVERSITY."

DR. BOHR HAS JUST HEARD THAT THERE IS NEW PROOF THAT THE SPLITTING URANIUM DESTROYED MASS, AND...

ENERGY MUST HAVE BEEN RELEASED! WE MUST CHECK FURTHER.

EINSTEIN WAS RIGHT. COME... LET'S TRY IT IN OUR OWN LABS!

IN THE MANY EXPERIMENTS THAT FOLLOWED, SCIENTISTS IN AMERICA DISCOVERED THAT, STRANGELY ENOUGH, ONLY A CERTAIN KIND OF URANIUM SPLIT.

KIND OF URANIUM? DIDN'T YOU TELL ME ALL URANIUM WAS THE SAME WITH 92 PROTONS?

ISOTOPES

"YES, JOHNNY, BUT FOR SOME UNKNOWN REASON—ABOUT ONE OUT OF EVERY 140 COMMON URANIUM ATOMS HAS THREE LESS NEUTRONS. INSTEAD OF WEIGHING 238 AS MOST OF THEM DO, IT WEIGHS ONLY 235. U235 IS THE ONLY KIND THAT SPLIT!"

COMMON URANIUM
92 PROTONS
146 NEUTRONS
238 MASS

U238



RARE URANIUM
92 PROTONS
143 NEUTRONS
235 MASS

U235



I GET IT... YOU NEED U235 TO SPLIT... AND TO RELEASE ENERGY.

THAT'S RIGHT, JOHNNY... BUT WE STILL DON'T HAVE USABLE ENERGY, YOUSAY...





YOU CAN HARDLY IMAGINE THE POWER OF THE SUDDEN RELEASE OF ENERGY IN UNCONTROLLED CHAIN REACTION...



WOW! SO THAT'S HOW THE ATOM BOMB WORKS!

YES, BUT AS RECENTLY AS 1940, IT SEEMED IMPOSSIBLE TO GET ENOUGH PURE U235 TO MAINTAIN A CHAIN REACTION. HERE'S WHY...



"IT WAS ALMOST IMPOSSIBLE TO SEPARATE U235 FROM U238 BECAUSE THEY BOTH ARE THE SAME ELEMENT. BUT WE FINALLY FOUND A WAY TO DO IT ON A SMALL SCALE..."

AT THIS RATE IT WILL TAKE US CENTURIES TO SEPARATE ENOUGH U235!

THERE IS ONLY ONE OUT-IT BIG ENOUGH TO HANDLE THIS JOB.



MR. PRESIDENT, PROFESSOR EINSTEIN ASKED THAT HIS LETTER BE DELIVERED TO YOU PERSONALLY.

...PROBABLE THAT A NUCLEAR CHAIN REACTION CAN BE SET UP... VAST AMOUNTS OF POWER... GENERATED.



"AND THE PRESIDENT OF THE UNITED STATES BROUGHT TOGETHER HISTORY'S LARGEST COMBINATION OF..."

"THE FABULOUS RESOURCES OF THE WORLD'S RICHEST NATION"

"THE KNOW-HOW OF AMERICA'S GREAT BUSINESS LEADERS"

"THE KNOWLEDGE OF THE WORLD'S MOST BRILLIANT SCIENTISTS"

"AN ARMY OF SKILLED INDUSTRIAL WORKERS"

... TO BUILD A TREMENDOUS NEW INDUSTRIAL CITY TO SEPARATE U235 FROM ITS CHEMICAL TWIN, U238."

"THE SECURITY OF MILITARY POWER"



"JOHNNY, TEAM WORK CAN DO ANYTHING! GENERAL ELECTRIC AND OTHER COMPANIES DID THEIR SHARE OF THE IMPOSSIBLE BY BUILDING MANY SPECIAL KINDS OF ELECTRICAL EQUIPMENT IN RECORD-BREAKING TIME... AND SOON..."



"IN THE MULTI-MILLION-DOLLAR PLANT AT OAK RIDGE, ENOUGH PURE U235 WAS SEPARATED TO START A CHAIN REACTION."

"YES, ALL THAT JUST TO MAKE A BOMB."

"TO END THE WAR QUICKLY, NO EFFORT WAS TOO GREAT, JOHNNY... AND WE TRIED TO PRODUCE ANOTHER SOURCE OF ATOMIC POWER."



"WE FOUND OUT IT COULD BE DONE ON DECEMBER 2, 1942 IN A SECRET EXPERIMENTAL LAB UNDER THE 'STACKS FIELD' BRANDSTAND IN CHICAGO..."

"IT'S WORKING! WE'VE SET UP A CONTROLLED CHAIN REACTION!"

"AND WE'RE CREATING PLUTONIUM!!"



"PLUTONIUM, WHAT'S THAT?"

"IT'S A NEW, MAN-MADE ELEMENT, JOHNNY... MADE FROM THOSE PLENTIFUL U238 ATOMS WE HAD THOUGHT USELESS."



"IN A REACTOR OF URANIUM, THE CHAIN-REACTION OF U235 CHANGES U238 ATOMS INTO OX PLUTONIUM."



"AND THE EASIER-TO-SEPARATE PLUTONIUM CAN MAINTAIN CHAIN REACTION JUST LIKE U235?"

"AND SO, AT HANFORD, WASHINGTON, UNCLE SAM BUILT A GREAT NEW KIND OF PLANT. IT'S NOW OPERATED BY GENERAL ELECTRIC FOR THE ATOMIC ENERGY COMMISSION... AND THERE WE'RE MANUFACTURING PLUTONIUM IN GIANT 'REACTORS'."



"WHAT'S THIS 'REACTOR' YOU'RE TALKING ABOUT, ED?"

"THEY'RE 'FACTORIES' WHERE WE CAN CONTROL A CHAIN REACTION OF SPLITTING ATOMS... LIKE THIS..."



"NOTICE HOW THE WOODEN MATCH STICKS SLOW DOWN THE CHAIN REACTION OF THE MATCH-HEADS..."



"IN A 'REACTOR' URANIUM RODS ARE SEPARATED BY GRAPHITE TO SLOW DOWN THE NEUTRONS."



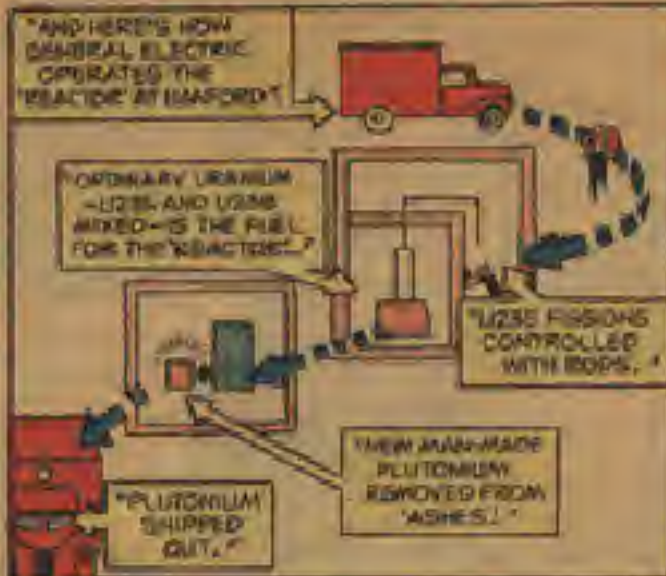
"UH HUH... BUT, WOULDN'T THE 'REACTOR' FINALLY EXPLODE ANYWAY?"

"NO, BECAUSE... JUST AS THIS WET BLOTTER CAN PREVENT THE FIRE FROM SPREADING..."



"...ADJUSTABLE CONTROL RODS IN THE REACTOR ABSORB NEUTRON BULLETS... THE MORE 'BLOTTING' RODS THE LESS FISSIONS..."





"IN BOTH LABORATORIES AND PRODUCTION PLANTS, SAFETY IS ASSURED IN MANY WAYS..."



BUT, NO, WE
STILL HAVEN'T
GOTTEN AROUND
TO USEFUL
ATOMIC POWER!



WELL, YOU HAVE TO
ADMIT WE'RE GETTING
CLOSE... EINSTEIN'S THEO-
RY--AND THE TREMEN-
DOUS ENERGY RELEASED
IN EACH NUCLEUS-SPLIT
--AND OUR CONTROLLED
CHAIN REACTION... NOW,
FOR THE LAST STEP...



"WE'RE BUILDING 'THE KNOLL' ATOMIC
POWER LABORATORY" NEAR SCHINECTADI,
NEW YORK, WHERE WE WILL LEARN
TO USE ATOMIC FUEL..."



"...AND WE EXPECT TO USE ITS TREMENDOUS HEAT ENERGY
TO GENERATE ELECTRICAL POWER-- PERHAPS-- LIKE THIS..."



